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*The Surgical Treatment of Suppurative
Pericarditis.*

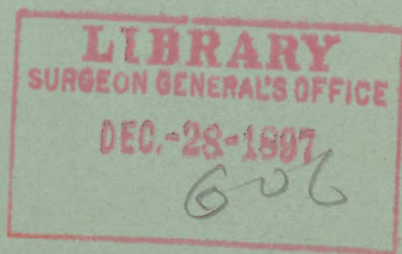
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(A Contribution from the Surgical Laboratory of the Philadelphia Polyclinic.)

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THE SURGICAL TREATMENT OF SUPPURATIVE
PERICARDITIS.¹

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COLLEGE OF PENNSYLVANIA.*(A Contribution from the Surgical Laboratory of the Philadelphia Polyclinic.)*

THE invitation to open the discussion on this topic has been accepted with pleasure, because I have long been interested in pericardial surgery. Studies made some twenty years ago convinced me that effusions in the pericardium should be treated by surgical measures similar to those adopted in pleural accumulations. At that time (1876) I suggested that purulent pericarditis be treated by the insertion of a drainage-tube into the pericardial cavity.² The proposal was thought by many to be rash and unworthy of surgical consideration.

Rosenstein, however, adopted this method of dealing with the disease in 1879, and saved his patient. He was followed by West, in 1882, with equally gratifying success. It has been supposed that these were the earliest recorded cases in which suppuration within the pericardium had been treated by incision and permanent drainage. Within a few weeks, however, I have found reported³ the case of Hilsmann. (Case No. 1 in table.) He operated in 1844 upon a man who had been sick about eight months, and evacuated several tumblerfuls of pus by an incision in the fourth intercostal space. The opening was kept patulous by the frequent insertion of a probe. The patient recovered. Langenbeck,⁴ in 1850, treated with similar success a purulent pericarditis occurring subsequent to necrosis of the ribs due to gunshot-fracture. (Case No. 2 in table.)

I reached the conclusion in 1881⁵ that pericardial incision and suture of cardiac wounds might be successfully accomplished, and should be

¹ Read at the meeting of the American Surgical Association, May 4, 1897.

² New York Medical Journal, December, 1876. Idem, April, 1877, p. 384. Paracentesis of the Pericardium, Philadelphia, 1880, p. 55.

³ Ueber die Paracentese des Pericardiums. F. A. Hilsmann, Kiel, 1875.

⁴ Vorlesungen über Akiurgie, Berlin, 1888, p. 449.

⁵ Annals of Anatomy and Surgery, Dec., 1881, p. 250, and Medical News, January 18, 1883.

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undertaken. Dalton,¹ within recent years, successfully resected six inches of the fourth rib for stab-wound of the pericardium and sutured the pericardial sac with a continuous catgut suture.

Williams² successfully ligated wounded internal mammary vessels and stitched the pericardium in a patient who had been stabbed and received a wound of the heart-wall. He resected part of the fifth cartilage. The patient was well over three years later. Schnitzler³ protected a torn pericardium with iodoform gauze when suturing was difficult. The pericardium has been torn and the heart exposed during the resection of the thoracic wall for chondroma, and recovery has followed. Rehn recently showed,⁴ at a meeting of German surgeons, a man upon whom he had fourteen days previously sutured a stab-wound of the right ventricle after costal resection and enlargement of the pericardial wound. A stab-wound perforating the pericardium, going through the diaphragm and injuring the liver, was treated successfully by Bouffleur,⁵ who opened the abdomen and sutured the diaphragm. Ferraresi⁶ resected three costal cartilages in a wound of the mammary artery and heart, and used gauze, applied with moderate pressure, to restrain the bleeding from the heart-wall. The injury of the cardiac muscle was not deep. His patient recovered.

These reports prove that the pericardium and heart do not resent a properly conducted surgical attack, and render a discussion of the topic selected valuable.⁷

PERICARDOTOMY and provision for thorough drainage are always demanded by the presence of pus in the pericardial sac. The etiology of the purulent condition should have no influence in deciding the question of treatment.

The suppurative pericarditis may be primary—a rare condition,—it may be secondary to serous or hemorrhagic pericarditis, to suppurative pleuritis or mediastinitis, to septic processes in distant regions, or to trauma; but the surgical indication is unvarying. Tubercular pericarditis, and pyopericardium, due to rupture into the pericardium of an abscess situated below the diaphragm⁸ or elsewhere, require in the same way pericardotomy and removal of the puruloid or purulent accumulation.

The accessory treatment must be varied in accordance with accompanying general or local deviations from the physiological state. Rheu-

¹ *Annals of Surgery*, 1895, xxi. p. 147.

² *New York Medical Record*, March 27, 1897, p. 437.

³ Rullier in *Arch. de Méd. et de Pharm. Militaire*, January, 1896, p. 110.

⁴ *Medical News*, December 5, 1896.

⁵ *Chicago Clinical Review* (1892-93), i. p. 30.

⁶ *Gazz. Med. di Roma*, 1896, xxii. p. 29.

⁷ Parrozzani has recently cured by suture of the heart a case of penetrating stab-wound of the left ventricle. Reported by Brock in *Lancet*, July 31, 1897, p. 260.

⁸ See Varga's case, *Gaceta Médica de México*, 1887, xxii. p. 256.

matism, scurvy, pneumonitis, pleuritis, tuberculosis, empyema, abscess, and pyæmia require efficient medicinal and surgical therapeutics. The remedial measures employed for these conditions must never, however, be allowed to interfere with the instant and complete rescue of the heart from the dangers incident to the presence of pus in the pericardial cavity.

Let the attendant administer antirheumatic, antiscorbutic, tonic, or other remedies, and aspirate, tap, or drain pleural sac or abscess-cavity; but these important measures must not delay the essential incision into the pericardium.

The improbability of pus becoming absorbed is great in all suppurative lesions; caseation or absorption of puriform material in tubercular conditions does not generally occur. It has been said¹ that small pleural empyemas may undergo spontaneous cure, but this is by no means to be expected. Modern surgery seldom suspends its activity when purulent or puruloid deposits in any region are to be treated. Such deposits within the pericardium demand early evacuation even more imperatively. The mechanical effects of the hydrostatic pressure on the heart's action and the degenerative changes indirectly produced in the cardiac muscle must be averted.

The diagnosis of pericardial exudation is made by the physical signs and the symptoms. That the fluid in the pericardium is pus must usually be demonstrated by exploratory aspiration. When this confirmatory evidence has been obtained, pericardotomy is to be performed with as little delay as is commensurate with satisfactory operative facilities.

Thick pus, shreds of floating lymph or false membrane, or a needle of too small calibre may interfere with the demonstration expected by the use of aspiration. Under such circumstances the surgeon may be pardoned for delaying operative treatment a little while. A few days' time, not more, may be given to further study and therapeutic expectation; then an exploratory incision down to the pericardium must be made if the physical signs continue to suggest effusion.

Purulent pericarditis sometimes causes no fever and no local œdema. A dilated heart may present signs and symptoms so similar to pericarditis with effusion that inspection of the heart or its surrounding sac may be the only means of ascertaining the truth. I recommended diagnostic incision in such obscure cases as long ago as 1881,² and have seen no reason to change my opinion as to its value and desirability. If there is a probability, therefore, that the patient's urgent symptoms are due to either pericardial effusion or cardiac dilatation, and competent medical examiners cannot determine the exact lesion, exploratory

¹ Parker, Trans. London Clinical Soc., 1889, xxii. p. 66.

² Annals of Anatomy and Surgery, December, 1881, p. 250.

incision is to be adopted. If this establishes the fact of effusion, puncture of the exposed pericardium will prove or disprove the existence of pus or serum. If pus be found, an incision should be made and permanent drainage established by stitching the pericardium to the skin or inserting tubular or gauze drains. Should the effusion prove to be serous, the puncture may be utilized to evacuate the entire quantity of effusion, and drainage may be omitted. The fluoroscope and skiagraphs will sometimes aid in diagnosis of obscure cases, but the apparatus is not always obtainable.

There is little dissent from the opinion that purulent accumulations in all regions require surgical intervention, lest the patient die of septic sequences or the pus be evacuated into neighboring cavities before nature can provide for its spontaneous exit. The supposed vulnerability of the heart long prevented the application of this principle of treatment to the pericardium. As a consequence, patients died with several pints of pus in the pericardium,¹ and autopsies sometimes revealed a burrowing sinus, reaching nearly to the surface; proving that the imprisoned pus was vigorously endeavoring to escape, that life might be saved.

Numerous recorded cases show the inutility in purulent cases of tapping, even if repeated. Gooch² tapped a case six times and injected iodine solution. The patient died in thirty-eight days. The survival for such a long period suggests that the boy might have been saved if the purulent fluid had been evacuated by incision at the first operation. In a case reported by Doubleday³ seventeen pints of pus were withdrawn from the pericardium by ten aspirations in the course of thirty-four days; then death occurred. In Villeneuve's case⁴ recovery subsequent to pericardicentesis occurred after the persistence of a fistule at the seat of operation for nearly six months. The effusion was originally serous, but became purulent.

Death occurring after tapping has revealed great quantities of pus still in the pericardial sac, though large amounts had previously been removed. Smith found⁵ thirty-six fluidounces at autopsy, though thirty fluidounces of pus had been withdrawn by aspiration. In some cases the original accumulation had been incompletely withdrawn; in others more pus had formed and had been denied escape because no permanent opening had been provided. In an autopsy made by Parker, in a case not operated upon, the distended pericardium reached to the

¹ In the New York Medical Record, March 9, 1895, p. 314, is recorded a case in which 2600 c.c. of pus and lymph were found at autopsy. See also Brit. Med. Journal, December 1, 1888, p. 1219; Gaz. Hebdom. de Méd. et de Chir., January 12, 1883, p. 25, and Brit. Med. Journal, 1885, i. p. 1246.

² Brit. Med. Journal, June 19, 1875.

³ New York Med. Journal, September 1, 1888, p. 232.

⁴ London Med. Rec., September 15, 1875, p. 532.

⁵ New York Med. Rec., February 12, 1876, p. 110.

anterior vertical axillary line on both sides and "sat like a saddle upon the lungs."¹

Such observations show that aspiration and puncture afford only temporary relief in suppurative pericarditis, and that a free exit for the pus must be maintained for a varying length of time, until the internal surfaces of the cavity become modified or mutually adherent. The entrance of air into the pericardium during this time does no harm.

DRAINAGE of the pus may be maintained by stitching the incised pericardium to the edges of the cutaneous wound, by the insertion of drainage-tubes, or by the introduction of a gauze wick, which must be frequently renewed. Stitching the pericardium to the edges of the wound has the advantage of possibly preventing pus leaking into the pleural sac, if it has been opened by the surgeon during the pericardotomy. The method of operating which I recommend avoids this contingency. If, however, the pleura is cut, suture of pericardium to the skin is a judicious procedure when it can be done, for there is little doubt that secondary pleuritis, due to infection from leakage of the pericardial pus, is a real danger. Delorme and Mignon report² a case of suppurative pericarditis which died after tapping with a trocar in the fifth interspace 6 cm. to left of the sternal border. Pleuritis occurred suddenly after the pericardial tapping. Autopsy showed that the pleura had been wounded, and the pus in the pleural sac had similar bacteriological characteristics to that in the pericardium.

If the pleura is known not to have been punctured, drainage by a large but short rubber tube is probably the best method. It does not need renewal as does the gauze wick, and can be utilized for irrigation if the surgeon decides to use irrigation. Two short drainage-tubes, placed side by side, like the barrels of a double-barrel shotgun, are the most satisfactory in cases where irrigation is to be employed. The cleansing or antiseptic fluid is then allowed to flow in through one tube and out through the other, as in washing out the bladder by a two-way catheter. The catastrophe which happened in Parker's case (No. 14 in the table) would not then be likely to occur. His patient apparently died from pressure on the heart made by the irrigating fluid failing to escape from the pericardial sac.

THE PROGNOSIS after incision and drainage is good, provided the operation is done early and no serious complications have preceded or followed the surgical treatment. West saw his first case nine years later in good health, and Davidson's case had no cardiac or pulmonary symptoms when seen nine months after operation. Many of the cases of death recorded in the subjoined table are attributable to pyæmic infection, of which the pyopericardium was a mere incident.

¹ Trans. Clinical Soc., London, 1889, xxli., p. 63.

² Revue de Chirurgie, 1895, xv. p. 1016.

The relief due to the evacuation of the pus was great, but naturally it alone could not restore the patient to health, and he died of his general disease. In some cases death would probably have been averted if the pericardial condition had been promptly and efficiently treated. Delay causes myocarditis, cardiac debility, and exhaustion of the patient in secondary suppurative pericarditis; and in primary suppuration within the pericardium gives opportunity for general septic infection in addition to these risks.

The combination of pleuritis and pericarditis is quite frequent. It is probable that either may be the primary condition, leading to the other as a secondary inflammation by contiguity of structure or continuity of vascular connection. The histories in the table seem to show that, in some instances at least, the pleuritis has been caused by the surgeon's pericardial puncture or incision being made through the pleural sac, and thereby permitting its direct infection from the pus in the pericardium. This can be avoided in nearly every case by a properly planned operative attack.

The prognosis is sure to be bad in cases where delay has permitted enormous quantities of pus to distend the long-suffering pericardial sac, the patient's strength to be exhausted, his kidneys congested, the cardiac muscle degenerated, and perhaps the pericardial pus evacuated by ulceration into the bronchial tubes.¹

The results obtained by incision and drainage in tubercular peritonitis suggest that drainage in tubercular pericarditis may lead to a permanent cure. The ease with which the pericardium can be irrigated with solutions of iodoform would seemingly add to this probability of success.

RESULTS. In the table of thirty-five cases of suppurative pericarditis of all kinds treated by incision fifteen recovered and twenty died. This gives a ratio of recovery of nearly 43 per cent. Of the fatal cases ten at least were evidently septic before operation. Excluding those known to be septic, only ten died out of the thirty-five cases. Of these ten there are complications, such as purulent pleuritis, or pleural, pulmonary, renal, or cardiac lesions mentioned in every instance except one, in which no statement is made (Case 28). Such a showing is very satisfactory when it is known that without operation practically all cases die, and that with repeated aspiration nearly every case reported has terminated fatally. The experience of Fiedler² and others shows that this statement is true.

In a few cases, as in that of Villeneuve,³ aspiration has been followed by recovery because nature established drainage by the formation of a

¹ Allende's case. *Revista de la Sociedad Medica Argentina*, 1895, iv. p. 20.

² *Sammlung Klinischer Vorträge, innere Medizin*, 1881, No. 72.

³ *London Medical Record*, September 15, 1875, p. 582.

fistule. Doubleday¹ states that Wyss reports a case of pyopericarditis in which a fistule formed spontaneously and lasted for years. Death finally occurred from an attack of acute pericarditis. In Newman's case (No. 9 of table) aspiration was repeatedly performed; but after a month of this palliative treatment drainage and subsequently incision were adopted. When death occurred, a few days later, it was discovered that nature had been endeavoring to supplement the surgical treatment by establishing in the second interspace a fistule from the pericardium to the surface. The canal had reached the subcutaneous tissue, but had not yet perforated the skin. This case shows nature's contempt for anything less than complete evacuation of purulent effusions, and is an indication that the proper surgical treatment in suppurative pericarditis is incision and drainage.

It is true that Douglas² reported a case of pus in the pericardium, treated by simple aspiration, that had not died up to the time of the report. The report, however, was made only thirty days after operation, and then the patient was expectorating purulent matter, due possibly to a communication between the pyopericardium and bronchial tubes. This case, therefore, affords no argument in favor of delaying incision and drainage. Langenbeck mentions³ a case which was cured after the use of the trocar, but he gives no details. The trocar may have been so used as to permit permanent drainage.

Incision has also the advantage of reducing to a minimum the danger of wounding the heart. This organ has been punctured on a number of occasions in attempts to tap a distended pericardium with a trocar or an aspirating needle. Sometimes this has occurred from a mistaken diagnosis. It may also happen, however, because the heart has become adherent to the anterior wall of the pericardium. Even with such adhesion a large and dangerously oppressive effusion may exist behind and at the sides of the heart. Diagnosis may then be difficult, because the heart-sounds will not be muffled.

Barlow reports⁴ experimental punctures made after death on two cases of pericardial effusion. All the punctures made to the left of the sternum resulted in the aspirating needle entering the heart-wall and obtaining no fluid; but punctures made at the right side of the sternum reached the effusion without cardiac injury. The distinctness of the heart-sounds during life induced him to hesitate in adopting pericardicentesis, for the diagnosis was not certain. If he had aspirated in

¹ New York Medical Journal, September 1, 1888, p. 232.

² Trans. Detroit Medical and Library Association, January, 1879, and Paracentesis of the Pericardium. John B. Roberts, Philadelphia, 1880, p. 93.

³ Vorlesungen über Akiurgie, Berlin, 1888, p. 450.

⁴ British Medical Journal, December 1, 1888, p. 1220. See also Churton, Trans. Clinical Soc. of London, xxv. p. 43.

the usually accepted locations, he would have injured the heart and would have obtained no fluid; if, however, he had adopted incision as recommended in this paper, the diagnosis would have been cleared up, the fluid found, and the lives of the patients possibly saved.

Money relates¹ a very remarkable case where at autopsy twenty-four fluidounces of pus were found in the pericardium, "almost entirely stowed away behind the heart." The amount was not appreciated, even when the chest was opened, until the heart was moved. I and others have invented peculiar aspirating needles to avoid wounding the heart, when the effusion has been nearly all evacuated; but these devices will not avert puncture of an adherent heart or evacuate serum or pus confined behind the heart by intrapericardial adhesions.

Delorme and Mignon found² in one of their dissections a vein of such size lying on the front of the pericardium that a free hemorrhage would have resulted from its puncture. Such a complication is avoided by operating by an incision, which also prevents injury to the internal mammary veins and artery, should they be unusually located.

These observations and other reported cases not here mentioned have almost convinced me that incision is better than aspiration even in cases not supposed to be purulent. It establishes diagnosis in dubious cases, avoids cardiac injury, saves the pleura from puncture, affords complete evacuation of effusion, permits extraction of thick pus and membranous lymph, and gives opportunity for disinfection of the sac when that is necessary. Rullier³ found it necessary to finally incise and drain a serous pericarditis which he had previously aspirated four times, even following the aspiration on two occasions with injection of tincture of iodine. The incision was done under local anæsthesia with cocaine. The patient recovered.

IRRIGATION has been adopted as an adjunct to incision in a number of cases. No immediate harm has seemed to result except in Parker's case (No. 14); the child in that instance died during the irrigation, immediately after the incision, apparently from pressure on the heart exerted by the irrigating fluid. Irrigation was used to encourage the evacuation of the thick pus, which did not flow well; but the water did not escape on account of the pericardial opening becoming plugged with thick pus or membranous lymph. The child was pyæmic, and the heart, which was very weak, stopped beating.

It is certainly essential that the outflow of fluid be unimpeded when irrigation is employed. The fact that plugging, sufficient to prevent the escape of the irrigating fluid, occurred in this case would seem to indicate that something more than an incision was needed to empty the

¹ *Lancet*, Octoer 18, 1890, p. 818.

² *Revue de Chirurgie*, 1895, p. 829.

³ *Arch. de Méd. et de Chirurgie Militaire*, January, 1896, p. 7.

pericardium of the fibro-purulent material clogging the heart's action. Parker believes that he would have done better if he had given the heart a little time to recover strength after the first gush of pus before endeavoring to clear out the sac by irrigation. This would probably have been judicious.

The opinion of Sievers¹ that irrigation tends to produce adhesions and may delay convalescence is difficult to accept. The occurrence of intrapericardial adhesions to a greater or less extent would seem usually probable in suppurative pericarditis treated by evacuation; but case No. 18 seems to indicate that they need not occur.

More than one autopsy, made a long time after recovery from pericarditis, in non-suppurative cases, has shown the presence of adhesions. These were formerly thought to be the essential of cure. Pepper's case² showed complete adhesion fifteen months after aspiration.

Irrigation carefully performed with warm fluid gradually admitted to the pericardium, and given free vent by using two parallel drainage-tubes in the wound, ought to be beneficial in ridding the cavity of shreds of lymph and pus, and may perhaps modify the walls of the sac. I should prefer sterile salt solution at about 100° or 105° F., and would use it in cases in which there was much lymph mixed with the pus. If the heart is very weak, it may be wise to wait for a few hours after the pericardotomy. Daily repetition of the irrigation seems desirable if the drainage instituted does not keep the sac empty.

Weak antiseptic solutions are unobjectionable for irrigation, but probably unnecessary. It has been suggested that the reflex irritability of the heart is modified by the false membranes, and that consequently irritants applied by irrigation cause little cardiac disturbance.

I would not inject solution of hydrogen dioxide into the sac, lest the effervescence within the cavity cause injurious cardiac pressure.

The direct extraction of shreds and membranous sheets by fingers and forceps is certainly judicious, when they can be seen or felt. Exploration of the interior of the pericardium with the finger and palpation of the heart itself are not objectionable under appropriate circumstances.

If the pyopericardium is one in which the pus is free from lymph and flows freely, irrigation may be unnecessary.

THE SITUATION at which the pericardium should be opened by simple tapping and by open incision deserves careful attention. In a former study³ I reached the conclusion that the best two points for pericarditis were close to the base of the ensiform cartilage, in the fossa between it and the seventh left costal cartilage and the fifth left inter-

¹ *Zeitsch. für klin. Med.*, 1893, xxiii. p. 45.

² *Paracentesis of the Pericardium*, John B. Roberts, Philadelphia, 1880, p. 79, and *New York Medical Journal*, December, 1876.

³ *Paracentesis of the Pericardium*, Philadelphia, 1880, pp. 65 and 67.

costal space, at from 5 to 6 cm. (2 to 2½ inches) to the left of the median line of the sternum. Of these two points preference was given to the latter for aspiration, even though its selection rendered perforation of the pleural cavity almost certain; but the importance of avoiding pleural injury in cases treated with a drainage-tube was recognized.

The puncture near the ensiform cartilage was regarded as an efficient route to the pericardium and one pretty sure to make the needle enter the pericardium without wounding either pleural sac. The chief risk in this location, perhaps, is that the diaphragm may be punctured if pericardial effusion is not present or if the surgeon does not direct the needle a little upward as he perforates the thoracic wall. Rotch's point in the fifth interspace, at 4½ to 5 cm. to the right of the edge of the sternum, is objectionable because it opens the right pleura.

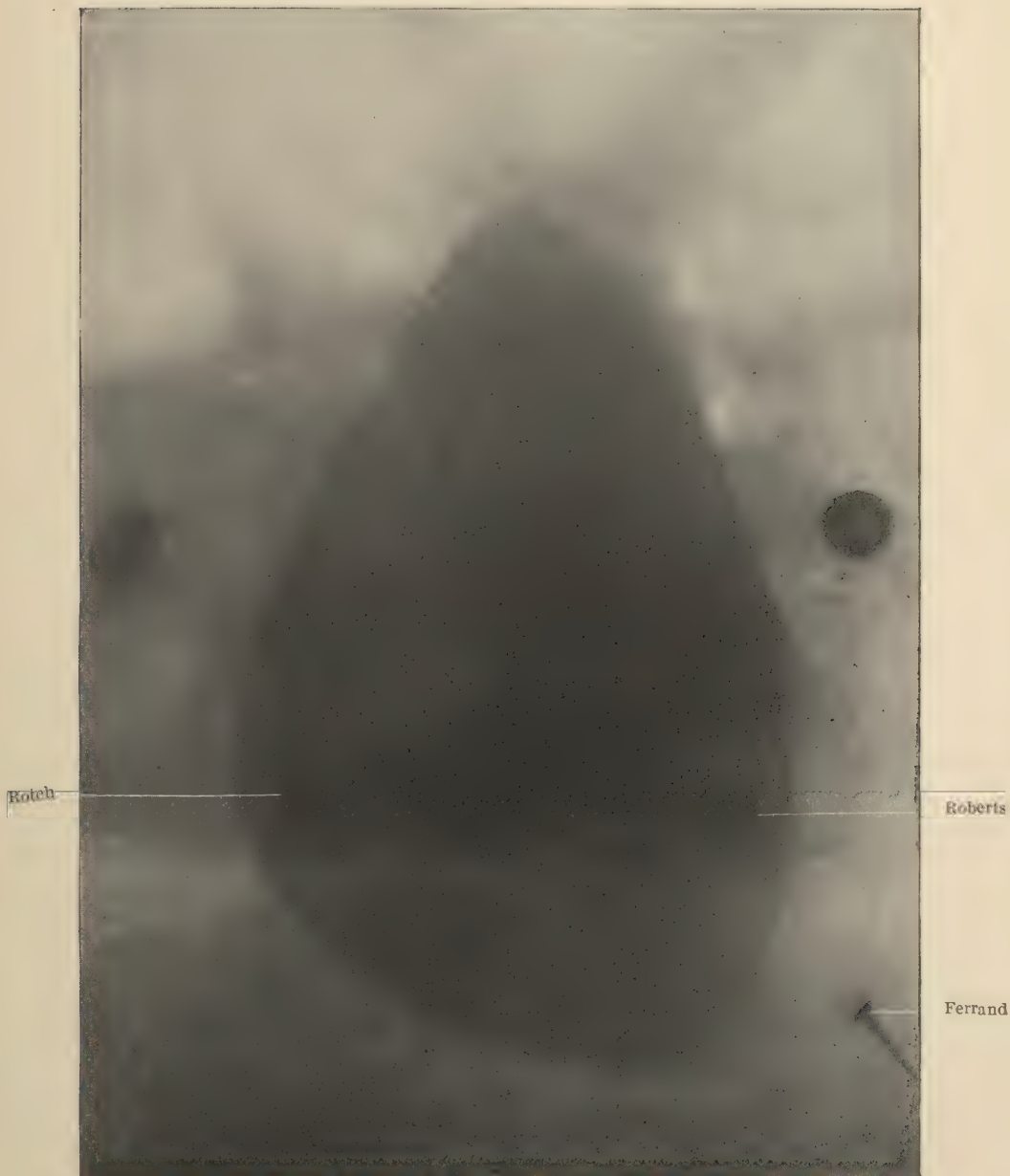
The danger of infecting the left pleural cavity by the pus within a pyopericardium, when the pericardium is punctured or incised in a location which causes a penetrating wound of the pleural sac, is not a theoretical one. This is shown by cases in which serous or suppurative pleuritis has arisen, after pericardicentesis or pericardotomy in the usually selected locations known to open the pleura.¹ While it is true that pleuritis may occur as the primary condition and pericarditis as the secondary lesion, or that both may arise from the same cause, clinical and bacteriological experience seems to show that direct infection from the pericardium to the pleura is a real danger. It is probably much less real, to be sure, in cases of hydropericardium or serous pericarditis than in suppurative pericarditis, since the effusion is apt to be less infective in character.

Ferrand² believes the point of election for tapping the pericardium to be in the fifth intercostal space, in a line vertically below the nipple, when the effusion is moderate; in the sixth intercostal space, on the same vertical line, if the signs denote a large effusion. He arrived at these conclusions by studying the limits of the pericardium and the downward displacement of the diaphragm after experimental introduction of fluid. He found that the arch of the diaphragm was lowered about 2 cm. in the recumbent position when 600 grammes of fluid were introduced, and that the depression was 3 cm. when the cadaver was put in a sitting posture. With 1100 grammes of plaster solution in the sac the cardiac apex at the left angle of the pericardium was at least 6 cm. from the thoracic wall. Delorme and Mignon found³ the pericardium to be from 3 cm. to 5 cm. from the surface of the skin in cadavers.

¹ British Medical Journal, December 1, 1888, p. 1220; North American Journal of Homoeopathy New York, June, 1889, p. 392; see cases Nos. 3, 32, and 34 in table; Ashby's case of pericardial tapping through lung from scapular angle is interesting; Lancet, March 29, 1884, p. 560.

² Contribution à l'Etude de la Paracentèse du Péricarde, Bordeaux, 1893, p. 45.

³ Revue de Chirurgie, December, 1895, p. 830.



Skiagraph of a cadaver, in the pericardium of which about 740 c.c. of plaster-of-Paris solution had been injected. Tacks were thrust into the chest at the points recommended for aspiration by Rotch, Ferrand, and Roberts. The nipples are marked by the buttons.

Ferrand's points would puncture the pleural sac, and are, therefore, as unsatisfactory as that recommended by me in the fifth interspace.

Numerous dissections made by Delorme and Mignon show¹ that the edge of the left pleura is very variable in its relation to the left border of the sternum, and that the accepted points of puncture on the left side must often wound the pleura. This observation holds good for infants as well as adults. Puncture in the fifth and sixth interspace close to the sternum will not assure safety to the pleura, though it was formerly thought that here the pleura was out of harm's way.

That pathological lesions change the pleural relations to the pericardium very little was apparently proved by their dissection of cases of pericarditis and by injecting fluid into the pericardium. This is not surprising when it is recollected that the parietal pleura is fixed to the thoracic wall.

The statement made by Fowler² that the boundaries of the pleura are greatly displaced in pericardial distention is, I believe, erroneous. The lungs are usually displaced, and may be thrust far backward by the distended pericardium sitting upon them like a saddle; but the pleuræ seem to hold their usual relations to the anterior wall. Of course, the two layers may in some cases become adherent by a local pleuritis, and thus lead to local obliteration of the pleural cavity.

My dissections lead me to believe that Delorme and Mignon are correct in stating that the pleura is in great danger of injury from the punctures usually made. The left pleura in many dissections made by these writers was out of the way, however, of a puncture made in the left xiphoid fossa.

These considerations lead me to the conclusion that, in cases of suspected suppurative pericarditis, the exploratory aspiration to determine with certainty the existence of pus in the pericardium should be performed in the upper part of the left xiphoid fossa. The needle should be thrust upward a little and toward the median line of the sternum. In fat patients a small cutaneous incision should be made if it is difficult to locate with certainty the top of the xiphoid fossa. If this establishes the diagnosis, the pericardium should be incised and drained by resection of the fourth and fifth costal cartilages on the left side of the sternum, in the manner devised by me and described hereafter.

It is probable that even in non-suppurative pericardial effusions the left xiphoid fossa is the place of election for aspiratory puncture; but it does not afford room for incision and drainage. Hence in suppurative cases costal resection is to be adopted, because the pleura can then be readily pushed aside; the internal mammary artery, which may be as large as the radial, preserved from injury; and the surgeon have room

¹ *Ibid.*, December, 1895, and January, 1896.

² *Trans. American Surgical Association*, 1896, xiv. p. 161.

for extraction of membranes or clots, or for any intrapericardial manipulation demanding fingers or forceps.

More than one instance is recorded where an incision or puncture evacuated the pericardial effusion found to exist into or through the left pleural cavity. In some cases the operation was performed for a supposed pleural effusion; but a distended pericardium was found to exist, and was then tapped through the original wound. The cases of West (No. 6), Savory (No. 7), and Gussenbauer (No. 11) are illustrations of this error of diagnosis.

West speaks¹ of a purulent pleuritis in which the needle, after being thrust into the pleural sac and obtaining pus, failed to perforate the pericardium. The pericardial symptoms diminished, and he believed that the pericardium had been nicked and had then drained into the pleura.

RESECTION OF THE THORACIC WALL for obtaining access to the pericardium has been proposed or done by Ollier,² Durand,² Delorme and Mignon,³ and Williams.⁴ Durand's operation is a modification of that recommended by Ollier, and consists of the following steps:

"A cutaneous incision on the fifth costal cartilage, parallel to it and from 6 to 8 cm. in length. It should commence at the middle line.

"Isolation and rapid denudation of the cartilage with the aid of the bistoury.

"Resection of this cartilage, which should be commenced by separating it from its sternal attachments and raising it from within outward.

"To these fundamental manœuvres is added ligature of the internal mammary vessels at the upper and lower borders of the wound. These organs are thus put out of danger of secondary ulceration or of accidental perforation during the operation. The fingers then detach the *triangularis sterni*, the operative importance of which Delorme and Mignon have clearly shown. The fingers are then carried toward the middle line *under the sternum* and recognize the pleura. The distended pericardium is then seen. Displacement of the pleural sac is then attempted, the situation of which sac scarcely appears to be changed by the pericardial distention."

At this moment, if the displacement of the pleura is insufficient, or if the pericardium is hidden behind the sternum, the border of the sternum is cut away.

"Incision of the pericardium, which is widely accessible to sight and touch."

¹ British Medical Journal, December 1, 1888, p. 1220.

² Revue de Chirurgie, 1896, No. 6.

³ Ibid., December, 1895, and January, 1896.

⁴ New York Medical Record, March 27, 1897, p. 487.

After some little work on the cadaver I propose the following operation for pericardotomy: The details are, I believe, in some respects new, though the writers just mentioned have suggested simpler methods. After I had proved to my satisfaction the efficiency of the method on the dead subject, and its reliability in avoiding pleural wound, I was gratified to find that much the same method of opening the thorax had been used by Williams¹ in a case of stab-wound requiring pericardial suture, which had healed favorably. His operation was not devised to prevent pleural injury, but to get access to a wounded internal mammary artery. I had supposed my method entirely novel until I recently saw his paper.

My dead-house investigations and his experience on the living patient supplement each other in a way that convinces me of the admirable character of the operative procedure which I advocate.

The operation consists in making a sort of trap-door, consisting of portions of the fourth and fifth costal cartilages, which is turned upward by utilizing for a hinge the soft tissues in the third intercostal space. A vertical incision is made about 1 cm. to the left of the median line of the sternum, beginning on a level with the top of the fourth costal cartilage. This cut is carried through the skin and subcutaneous tissue to the sternum, and is continued downward to a point corresponding with the level of the upper border of the sixth cartilage. The length of this incision is from 4 to 5 cm.

A second incision is made parallel to the first, beginning at the upper border of the fourth rib, at from 4 to 5 cm. to the left of the commencement of the first incision. It is continued downward from the top of the fourth cartilage to the upper border of the sixth cartilage. The curve of the sixth cartilage requires this incision to extend downward a little further than the first vertical incision; but as the fourth rib also is a little concave upward, the second cut is nearly of the same length as the first. The second incision is made deep enough to divide all the tissues down to the cartilages. The lower ends of these two incisions are joined by a third cut carried along the upper border of the sixth costal cartilage.

The soft tissues to the left² of the first incision are separated from the sternum and pushed outward, so as to disclose the exact situation of the articulation of the fourth and fifth costal cartilages with the sternum. With a large scalpel, having a thick back, the fourth and fifth cartilages are divided as near as possible to the sternal border in such a way as to leave a bevelled surface of the cartilage attached to the sternum looking forward and outward. This section of the cartilages may be made with a Hey's saw, if the surgeon prefers. A thick-backed scalpel, with a cutting edge having a large belly, will be found a satis-

¹ Loc. cit.

² "Left" means the patient's left.



Author's Chondro-plastic Method of Pericardotomy, by a Trap-door Excision of Costal Cartilages, which avoids Injury to the Pleura and Internal Mammary Vessels.

[The flap, consisting of portions of the fourth and fifth cartilages and the attached soft parts, is turned upward, exposing the left lung covered with pleura and the internal mammary vessels. The forceps is seen holding the vessels and the edge of the pleural sac outward, so as to expose the white pericardium, in which an opening, indicated in black, has been made.]

factory and safe instrument with which to divide the cartilages with the least danger to the tissues in the mediastinum.

The next step consists in dividing the cartilages immediately under the outer edge of the flap in a similar manner, leaving a bevelled surface to the portion left attached to the rib, which looks forward and inward toward the median line. The incision is near the junction of the ribs with the cartilages. Care must be observed to make the incision through the cartilage of the fifth rib vertically under the incision in the cartilage above. The tendency is to bring the incision inward toward the median line of the body, so that the opening made in the chest-wall becomes too narrow at the bottom of the flap.

In dividing the cartilages the operator must be cautious not to puncture the pleura, which is closely attached to the inner surface of the costal cartilages at the outer margin of the flap. There is less danger in making the costal incisions near the sternum, because in that region the muscular fibres of the triangularis muscle are immediately beneath the cartilages. The surgeon, having divided the cartilages completely, next cuts the intercostal muscles and soft tissues in the fifth, fourth, and intercostal spaces and along the upper border of the sixth cartilage.

The chondro-plastic flap is then carefully raised from its lower border and the tissues of the mediastinum are cautiously separated from the internal surface of the resected cartilages and the intercostal muscles. The trap-door is thus opened on the hinge at the upper border and the triangularis muscle exposed. Upon it, about 1 cm. from the border of the sternum, is seen the internal mammary artery and its two accompanying veins running parallel to the sternal edge. At the outer portion of the window the muscular fibres and fascia are thinner and cover the lung and pleura. An incision is made through the triangularis muscle, close to the sternum and therefore within the line of the internal mammary vessels; and is carried up and down as far as the opening in the chest-wall will permit.

With the finger or a curved blunt instrument the surgeon then separates the fascia and muscular fibres and pushes the outer part with the vessels and the double edge of the pleural sac outward toward the external border of the opening. The shining white surface of the pericardium is then seen lying behind the sternum and along the inner portion of the opening. The pleura, which often has considerable fat along its edge, like the appendages of the colon, may not be seen, because it is pushed out of the way without having the overlying fatty tissue separated from it. If it is seen, its transparency or pinkish color will distinguish it from the white and more opaque pericardium.

Injury to the vessels or pleura is thus averted during the pericardotomy, because they are pushed away from the proposed opening into

| No. | Operator and date. | Sex and age. | Duration of illness. | Complication. | Tapped previously. | Situation of incision. | Quantity of pus evacuated. | Irrigation. |
|-----|---|--------------|----------------------|---|---|---|--|------------------------------------|
| 1 | Hilsmann, 1844 | M. 25 | 8 mos. | None. | No. | 4th interspace, a finger's breadth from left edge of sternum. | About 1 quart; much more escaped within a few hours after operation. | No. |
| 2 | Langenbeck, 1850 | Not given | Not given. | Gunshot wound and necrosis of ribs. | No. | Where 5th rib was absent. | Not given. | No. |
| 3 | Rosenstein, 1879 | M. 10 | 23 days | Pleuritis. | Twice a few days previous with aspirator; pleura also tapped. | 4th interspace near sternum. | Great quantity. | No. |
| 4 | West, 1882 | M. 16 | 1 mo. | None. | Yes, three days previously. | 5th interspace in line of left nipple. | 2 quarts. | Carbolic acid sol. 1 : 40 |
| 5 | Partzevsky, 1882 (?) | M. 23 | 13 wks. | Pleuritis. | Yes, twice. | 4th interspace. | Not given. | Salicylic acid sol. |
| 6 | West, 1883 | M. 14 | Not given. | Pleuritis, pneumonia, abscess of thigh, arthritis. | Not given. | Opened with bistoury from wound to evacuate supposed pleural effusion. | 24 fl.oz. | Not given. |
| 7 | Savory (?), 1883 Reported by Brinton and Collings. | M. 9 | 7 wks. | Abscess of shoulder and thigh, pleuritis, pneumonia; serum obtain'd from pleura at two previous tappings. | No. | 5th interspace in ant. line of axilla; through pleural cavity, which was opened because effus'n believed to be pleural. | 24 fl.oz. | Yes, Condyl's fluid. |
| 8 | Scott, 1883 | M. 6 | 5 wks. | None. | Yes, with trocar one day previously; irrigation with carbolic acid solution, 1 per cent. | 5th interspace near apex beat. | Not given. | Yes, carbolic acid sol. 1½ p. ct. |
| 9 | Newman (or Stirling), 1885 | M. 32 | 2 mos. | Typhoid fever; pleuritis. | Yes, aspirated 4 times; 5th time a silver canula for drainage; carb. acid sol. & tinct. iod. sol. for irrig. First aspiration 1 month previously. | 3d left interspace; incision made where fistula existed from canula which had been draining the sac for three days. | 174 fl.oz. had been evacuated by the five previous tappings. | Tincture of iodine (B. Ph.) 1 : 10 |
| 10 | Mikhailov, 1885 (?) | F. 35 | About 3 wks. | Pleural, bronchial, and renal lesions. | Yes, two days previously. | 4th interspace near sternum. | 2 fl. lbs. ? | Boric acid sol. |
| 11 | Gussenbauer 1885 (?) | M. 13 | Not given. | Acute osteomyelitis at shoulder (left). | Not given. | 5th rib resect'd; open'd pericardium through pleural cavity because thought to be pleural effusion. | Not given. | Thymol solution. |

| Perma- nent drainage after incision. | Time of after- treat- ment. | Result. | Reference. | Remarks. |
|--|--------------------------------------|----------------|---|---|
| Yes, wound kept open by inserting probe. | Nearly 3 mos. | Recov- ery. | Ueber die Para- centese des Peri- cardiums. F. A. Hilsmann, Kiel, 1875. (Inaug. Dissert.) | The pericardium was opened behind the ster- num, though the external wound was a short distance to left of sternum. As the sac was gradually drained its walls contracted and the pericardial opening moved to the left. In a few days the opening was $1\frac{1}{2}$ inches to left of sternum and over the 4th rib. In order to empty the sac thoroughly when the external wound was dressed the patient had to bend over as if he was about to stand on his head. |
| Not given. | Not given. | Recov- ery. | Vorlesungen über Akiurgie B. von Langenbeck. Berlin, 1883, 449. | Patient had been wounded in a duel in which the bullet shattered five ribs. Necrosis had subsequently occurred and purulent pericar- ditis resulted. |
| Yes, two drainage tubes. | About 2 mos. | Recov- ery. | Berl. klin. Woch., Jan. 31, 1881, 62 | Pleuritis apparently occurred after tapping and incision of pericardium. |
| Yes, with drainage tube. | 5 mos. | Recov- ery. | Med.-Chirurg. Trans., 1883, 235. | Rod-shaped bacteria found in pus. Patient in good health nine years afterward. West be- lieves that pericardial adhesions had occurred, but there was no evidence of this condition. |
| Yes, with drainage tubes. | 30 hrs. | Death. | London Medical Record, Feb. 15, 1883, 33. | Autopsy showed cardiac hypertrophy with fatty degeneration, pleural adhesions, pulmonary cedema. |
| Not given. | 14 dys. | Death. | Brit. Med. Journ., Dec. 8, 1883, 1129; and Feb. 21, 1891, 404. | At autopsy found extensive pericardial adhe- sions. [Case of a septic nature most probably. —J. B. R.] |
| Yes, with drainage tube. | 15 dys. | Death. | St. Bartholomew's Hosp. Reports, 1883, xix. 271. | This patient is evidently the one referred to by West in Medico-Chirurgical Trans., 1883, as having been operated upon by Savory. Case was one of pyæmia. Autopsy showed no com- munication between left pleura and tract lead- ing through it to pericardium because adhe- sions had occurred. |
| Yes, two openings an inch apart with drainage tube through both. | Not given. | Recov- ery. | New Zealand Med. Journ., July, 1891, 268. | |
| Yes, with rubber tube. | 5 days. | Death. | Australian Med. Journ., July 15, 1885, 308. | First aspiration was done in 6th left interspace; second in 4th right interspace; in third and fourth aspirations no information as to point is given; fifth tapping done in 3d left inter- space; incision. At autopsy a sinus found in 2d interspace leading from pericardium to the subcutaneous tissue. This was nature's effort to obtain a spontaneous opening for the pus. Author suggests to us that it may give a hint as to best point for tapping. |
| Yes, with drainage tube. | 18 hrs. | Death. | Annals of Surg., Nov. 1885, quoted from Lond. Med. Record, Aug. 15, 1885, from native journal. | Autopsy showed cardiac dilatation with fatty degeneration, pleural and bronchial disease, and kidney lesions. Bacteriological examina- tion of heart and pericardium was negative. Original in Med. Oboz., Moscow, 1885. xxiii. 475. |
| Yes, by stitching pericar- dium to edges of wound. | Not given. | Recov- ery. | Wiener med. Wochen., Nov. 22, 1884, 1403. | Small fistule remained when case reported. |

| No. | Operator and date. | Sex and age. | Duration of illness. | Complication. | Tapped previously. | Situation of incision. | Quantity of pus evacuated. | Irrigation. |
|-----|-----------------------------------|--------------|----------------------|---|--|--|--|---|
| 12 | Rouse (Dickinson's patient), 1887 | M. 10 | About 15 wks. | Gluteal abscess, pleuritis; abscess of finger; pleura tapped 12 times, serum obtained. | Yes, three times; last time one week previously. | 5th inter-space right side close to sternum. | Not given. | No. |
| 13 | Underhill, 1887 | F. 6 | 2 days. | Pyæmia; had periosteal abscess of tibia a few weeks previously; autopsy: abscesses in kidneys and pleura. | Yes, aspirated twice, last time five days before incision. | 5th left inter-space close to border of sternum. | Over 10 fl. oz. | No. |
| 14 | Parker, 1888 | F. 9 | 6½ wks. | Osteomyelitis of tibia and suppurative arthritis of knee. | Yes, four days previously. | 4th inter-space along left border of sternum with resection of one inch of 5th costal cartilage. | "A large quantity" flocculent pus and lymph. | Yes. |
| 15 | Halsted (reported by Osier), 1890 | M. 36 | Over 3 wks. | Acute necrosis of bones of nose; albuminuria; congestion of right lung. | No. | 4th inter-space midway between nipple and sternum. | Over a quart. | No. |
| 16 | Delorme, 1890 | M. | 18 days. | Double pleuritis; empyema; operation. | No. | 4th inter-space a little outside of internal mammary vessels. | Few drops. | No. |
| 17 | Davidson, 1890 | M. 6 | Over 4 wks. | Metatarsal necrosis; subperiosteal abscess 8th rib right side; empyema; pneumonia. | No. | 5th inter-space. | 8 fl. oz. | No. |
| 18 | Davidson, 1890 | M. 6¼ | Nearly 4 wks. | Empyema; operated upon previously. | No. | 4th inter-space 1 inch from left edge of sternum. | Several fl. oz. | No. |
| 19 | Teale, 1890 (Bronner's patient) | F. 11 | 34 dys. | Influenza, pneumonia. Empyema operated on previously. | No. | 4th inter-space 1 inch from left edge of sternum. | Nearly 2 pints. | Yes, iodoform and glycerin solutions of boric acid and carbolic acid. |
| 20 | Deaver, 1890 | M. 21 | 18 dys. | Synovitis (?) of knee. | Yes, aspiration one day previously. | 5th inter-space 3 in. from middle line. | Not much but xxv removed by aspiration day before. | No. |
| 21 | Sievers, 1892 | F. 22 | 5 wks. | Pleuro-pneumonia, empyema on both sides; nephritis. | Yes, seven days previously with trocar. | 3d inter-space 2 cm. to left of sternum. | Great quantity. | No. |
| 22 | Körte, 1891 | F. 7 | | Osteomyelitis of both tibias. | Yes. | Resection of 5th rib for 5 centimetres. | ½ litre. | Lysol solution ½ per ct. |

| Perma- nent drainage after incision. | Time of after- treat- ment. | Result. | Reference. | Remarks. |
|--|--|----------------|---|---|
| Yes, with drainage tube. | 2½ mos. | Recov- ery. | Trans. Clin. Soc. Lond., 1889, p. 48; mentioned also in Holmes' Treatise on Surgery. | Case considered one of pyæmia. Patient lay on face at times to encourage drainage. |
| Yes, with drainage tube. | 5 days. | Death. | Edinburgh Hosp. Rep., 1896, iv. 200. | Several hemorrhages from interior of pericar- dium. Autopsy showed that the bleeding probably came from granulation tissue, on inner surface of pericardium, probably the seat of septic emboli. |
| Yes, stitched pericar- dium to edge of wound. | Death occurred during irriga- tion im- medi- ately after in- cision. | Death. | Trans. Clin. Soc. London, 1889, xxii. 60. | Pus did not flow well; it was thick and contained membraniform shreds; hence irrigation was adopted. Operator believed death was caused by irrigating fluid collecting in pericardium, as opening in pericardium became plugged with lymph. Patient was pyæmic. No special lesion found at autopsy, except pericardial changes. As opening in pericardium became plugged with lymph pressure on heart proved fatal. |
| Yes, with gauze plug. | 17 dys. | Death. | Univ. Med. Mag., vi. 248. | Great improvement after operation. Dr. Osler, who reports case, calls the pericarditis septic and attributes the fatal result to probable myo- carditis. No autopsy was made. |
| No. | Few mo- ments. | Death. | Revue de Chir., 1895, xv. 1008. | Patient died of asphyxia which had caused peri- cardial operation to be hurriedly undertaken. Autopsy showed front of heart adherent to peri- cardium, and about 500 grms. of sero-pus col- lected at base and sides of heart, and a great quantity of false membranes that could only have been removed by a large opening followed by washing and direct extraction. The open- ing in 4th space was over the adherent region. |
| Yes, with drainage tube. | 7 days. | Death. | Brit. Med. Journ., March 14, 1891, 578. | Autopsy showed no pericardial adhesions; pneu- monia. Case was considered septic. |
| Yes, with drainage tube. | Over 7 wks. | Recov- ery. | Brit. Med. Journ., March 14, 1891, 578. | |
| Yes, with drainage tube. | 26 dys. | Death. | Brit. Med. Journ., Feb 14, 1891, 350. | No autopsy made; but a probe passed into peri- cardium discovered no adhesions, though soft granulations were felt toward base of heart. |
| Yes, rub- ber tube. | 13 dys. | Death. | Univ. Med. Mag., 1894, vi. 297. | Autopsy showed much fibrinous exudate within pericardium. [Case of a septic nature most probably.—J. B. R.] |
| Yes. | 8 dys. | Death. | Zeitsch. für klin. Med., 1893, xxiii. 26. | Found bacilli in fluid. Autopsy showed acute nephritis, pleuro-pneumonia, pericardial adhe- sions, and some change in heart muscle. Peri- carditis was of a septic-pyæmic nature. Opera- tor chose 3d interspace because 4th and 5th spaces were very narrow. |
| Not given. | 12 dys. | Death. | Verhand. d. Berl. med. Gesellsch. (1892), 1893, xxiii. 2. | Autopsy showed numerous foci of pus in fissures of cardiac muscle, in papillary muscle of mitral valve, and in kidneys: caseous mass in lung and evidences of pleuritis were found. -Pus evacu- ated contained staphylococci, streptococci, and bacilli. [Case evidently septic.—J. B. R.] |

| No. | Operator and date. | Sex and age. | Duration of illness | Complication. | Tapped previously. | Situation of incision. | Quantity of pus evacuated. | Irrigation. |
|-----|------------------------------------|--------------|---------------------|---|---------------------------------------|--|---|---|
| 23 | Eiselsberg, 1894 | M. 17 | Over 4½ mos. | Wound by knife in reg'n of heart had healed; left pleuritis and pneumonia followed third tapping. | Yes, three times. | Resection of 4th cartilage. | 2 litres. | Yes, sol. of salicylic acid, then iodoform and glycerin |
| 24 | Edwards, 1892 (?) | F. 6 | Not given. | Sacculated empyema; opera'n with resec. of ribs; mediastinitis—nephritis. | No. | ¼ in. within and above position of apex beat. | 3ix. | No. |
| 25 | Jacobson | F. 14 | Not given. | Oedema of lungs. | Not given. | 5th interspace right side a little outside of sternum. | 3xlvj. | Not given. |
| 26 | Gabszewicz, 1892 | M. 22 | 1 mo. | None. | No. | Resection 5th costal cartilage. | Large quantity. | Yes, boric acid sol. |
| 27 | Robinson, 1893 | M. 16 | 20 days. | Sore-throat; swelling of left wrist first symptom. | Yes, aspiration one day previously. | Resection of 6th rib. | 2 quarts. | No. |
| 28 | Marsh | M. 14 | Not given. | Not given. | Not given. | Below the nipple. | Not given | Not given |
| 29 | Klefberg | M. 19 | | Influenza previously. | Yes, aspiration 150 grms. pus. | 4th interspace. | 1 litre pus. | |
| 30 | Bohm, 1894 | M. 33 | 1 mo. | Influenza previously; pleuro-pneumonia. | Yes, three times. | 3d interspace. | 1 litre. | Yes, boric acid solution. |
| 31 | Allen, 1892 | M. 11 | Not given. | Empyema requiring costal resection one year before. | Yes, aspiration. | Resected 6th rib below and inside left nipple. | 2 quarts. | Yes, with sterile water. |
| 32 | Stoker (O'Carroll's patient), 1892 | M. 20 | 34 days. | Pneumonia; left pleural effusion subsequent to operation. | Yes, aspiration five days previously. | 4th interspace midway between nipple and sternum. | Not given | No. |
| 33 | Björkman (or Hackzell), 1895 (?) | F. 12 | About 3½ wks | Influenza and pleuro-pneumonia previously. | Yes, in 4th interspace. | Resection 5th and 6th ribs. | 400-500. c. c. | Yes, boric acid solution. |
| 34 | Porter (Shattuck's patient), 1895 | M. 26 | 33 days. | Pneumonia before pericarditis; empyema afterward requiring resection. | Yes, aspiration two days previously. | 5th interspace 1½ in. to left of sternum. | 1 quart. | Yes, with sterile salt solution. |
| 35 | Garber, 1897 | F. 21 | 2 wks. | Pericarditis caused by penetrating wound with steel crochet needle. | Not tapped previously. | 5th interspace 1½ in. to left of sternum. | About 1 fl.oz. thick pus and also purulent fluid. | Yes; salt solution. |

| Perma- nent drainage after incision. | Time of after- treat- ment. | Result. | Reference. | Remarks. |
|--|---|----------------|--|--|
| Yes, two tubes. | About 6 wks. | Recov- ery. | Wein.klin.Woch., Jan. 10, 1895, p.21. | Drains kept in pericardium for seventeen days. |
| Yes, rub- ber tube. | Not given. | Death. | Trans. Med. Soc. of State of Cali- fornia, 1893, 166. | Began as mediastino-pericarditis with secondary pleurisy; at least this was the belief of Ed- wards after an autopsy. |
| Not given. | Not given. | Death. | Jacobson's opera- tions of Surgery, Lond., 1897, 590. | Death occurred from œdema of lungs. |
| Yes, by iodoform gauze for 18 days. Drainage tube. | Not given. | Recov- ery. | Gaz. Leklarsk, Warsaw, 1892, 2 ser. 12, 1070. | |
| | About 2 mos. | Recov- ery. | Lancet, Nov. 21, 1896, p. 1460. | |
| No. | 4 days. | Death. | Lancet, Nov. 21, 1896, p. 1460. | |
| | 6 days. | Death. | Tidskrift i Milit- är. Helseovord, 17 Arg. 1892, Stockholm, from Shattuck and Porter. Boston Med. and Surg. Journ., May 6, 1897, p. 444. | Autopsy showed pus in right ankle-joint and right sterno-clavicular joint. [Probably septic.—J. B. R.] |
| Gauze drain. | 3 mos. | Recov- ery. | Deutsche med. Wochen., Nov.26, 1896, p. 769. | Schleich's infiltration method of local anæsthesia was used. Out of bed in four and a half weeks. Wound closed in three weeks; well a year later. |
| Gauze drain. | 20 days. | Death. | Personal com- munication from Dr. D. P. Allen, Cleveland, Ohio. | |
| Drainage tube in- serted on 3d day. | 30 days. | Death. | Dublin Journ. Med. Sciences, July, 1896, p. 11. | Fränkel's diplococcus found in pus. |
| Yes, two large drainage tubes. Two rubber tubes. | 6 weeks | Recov- ery. | Hygieia. Stock- holm, lviii. pt. 2, p. 139, 1896. | Pleural cavity was opened during resection and some serum evacuated. The pleural opening was then sutured. |
| | On 36th day wound entirely healed; empy- ema; sinus finally closed in about 10 mos. | Recov- ery. | Boston Med. and Surg. Journ., May 6, 1897, p. 438. | Pneumococcus in pus; pneumothorax and em- pyema occurred after pericardotomy; then erysipelas of back and shoulder. Pneumococ- cus in pus from pleural sac. |
| Yes, with gauze. | 24 days. | Recov- ery. | Journ. Amer. Med. Assoc., June 26, 1897, p. 1223. | |

the pericardium. The pericardial sac is incised vertically or obliquely between the sternal border and the displaced vessels and pleura and a drainage-tube inserted. The length of the incision into the pericardium should be sufficient to permit extraction of membranes and thick pus. The surgeon's finger may be introduced for exploration.

If irrigation is employed, it is best to use two tubes, one to admit the fluid, the other to give it free exit. The drainage-tubes are introduced and brought to the surface through the fifth intercostal space, after trimming away the lower portion of the flap; and the chondro-plastic flap laid in position. If it is preferred, the tubes may be brought out through holes made in the flap between the fourth and fifth cartilages. The bevelled cartilages fit accurately together, and the flap will show little tendency to drop inward, even if the lungs and pericardium fail to support it. The cartilages may be sutured with catgut by passing the needle through their substance. In cutting the cartilages obliquely during the early part of the operation it is desirable not to bevel them too much, because the internal edges then project so far that it is difficult to get under the sternum. The bevelled surface should make an angle of about 45° with the internal surface of the cartilage.

It may be objected that this method of resecting the thoracic cage does not open the pericardium at its very bottom. It might be suggested to resect the fifth and sixth cartilages instead of the fourth and fifth. I prefer not to do this, because there is considerable danger of opening the abdomen when separating the outer end of the sixth cartilage from the underlying tissues. This danger would be less, of course, if a pericardial effusion had pushed the diaphragm downward. The manner in which the outer portion of the costal cartilage of the sixth rib runs obliquely downward renders the danger more imminent than might be supposed. Another objection to resecting the sixth cartilage is the common presence of a cartilaginous bridge between the sixth and seventh costal cartilages. This would complicate a little, though not to a great extent, the lifting up of the trap-door. Such a bridge sometimes occurs between the fifth and sixth cartilages.

Operators who have made similar resections of the chest-wall in operations for suppurative pleuritis have proved by skiagraphy that consolidation takes place if the perichondrium be retained. Restoration would certainly be much more probable in the operation which is here advocated, since not only the perichondrium but the cartilages themselves, with many of their connections, have been retained.

The evacuation of the fluid after opening the pericardium can be made complete at times by a change in the posture of the patient or breaking down adhesions by a probe or the finger introduced into the sac. It does not seem to be especially dangerous to allow the pus to flow out rapidly, but it is wise to permit the escape to be gradual.

Aspiration can be readily done under local anaesthesia by cocaine or freezing. Resection in the manner advocated will probably require general anaesthesia. If the severity of the symptoms renders general anaesthesia dangerous, it may be well to withdraw a portion of the fluid by the aspirator needle used for diagnosis in the xiphoid fossa, and delay drainage by incision and resection until the patient's condition will permit the administration of an anaesthetic. The patient should be allowed to remain recumbent or semi-recumbent during the operation. The tubes should be prevented from slipping into the pericardium by being stitched to the skin or having a safety-pin thrust through their outer ends.

Operations upon the pericardium for pyopericardium would seem, on general principles, to promise better results in a mechanical way than similar operations upon the pleura, for the pericardium is elastic and more easily drained than the pleura. If it becomes thickened and does not collapse after evacuation of pus, I would be inclined to incise any remaining fistule and cut away the thickened pericardial tissue.

Pericardial fistules should be treated as fistules elsewhere. After sufficient time has been given to make it clear that spontaneous healing will not occur, the fistule should be laid open and thickened tissue removed.

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